Close-in brown dwarfs and massive planets

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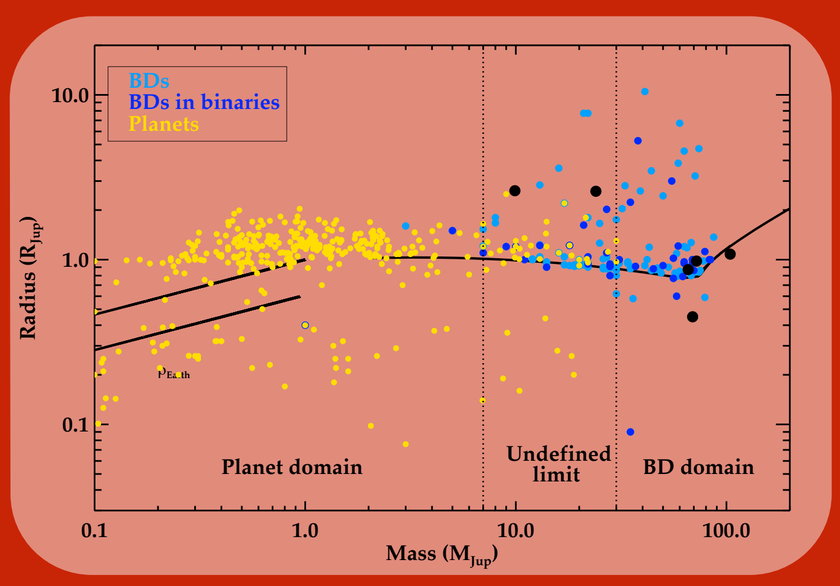
Abstract.- The explanation for the paucity of substellar objects in close-in orbits around FGK stars (the brown dwarf desert) has been discussed for long time. The *Kepler* mission has provided unprecedented photometric precision, letting us detecting and characterizing several of these systems, also including massive planets in close-in orbits around their hosts. In this poster, we present our recent detection of these type of objects by making use of the tidal deformations induced by these close companions with *Kepler* data. We contribute to fill the gap by deriving mass and radius for these substellar close-in companions, crucial for calibrating theoretical models.

Who's who?

Even though we already know thousands of extrasolar planets and hundreds of brown dwarfs, the boundary between both types of objects is still poorly understood.

The reasons are multiple but all of them reside in the fact that we lack a statistically significant sample of objects close to the commonly accepted boundary of 13 Jupiter masses (see red piece). Detecting and characterizing more objects in this niche can provide the clues to understand their differences.



The usual definition is based on whether the object is able to burn deutherium, placing the limit in 11.0-16.3 M_{Jup} (Spiegel et al., 2011).

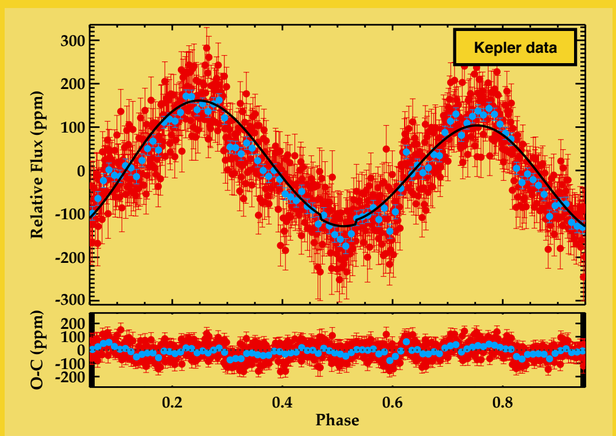
Formation and early evolution

Additionally, the detection and characterization of close-in massive planets and BDs is important to unveil their formation mechanism and their possible migration in the early stages.

How these massive objects reached such close-in orbits? Is the gravitational instability formation mechanism rapid enough to allow an early migration driven by planet/BD-disk interactions? Are other interactions playing a more important role in these systems?

Looking for close-in substellar companions in the *Kepler* sample

We have taken profit of the unprecedented photometric precision of the *Kepler* mission to look for light curve modulations in the sample of planet candidates (Lillo-Box et al., 2015c, in prep.). These variations allow the direct determination of the mass of the companion without radial velocity (RV) follow-up. Both the mass and the radius of the substellar object can be derived from this analysis, providing valuable information on its bulk composition and structure.

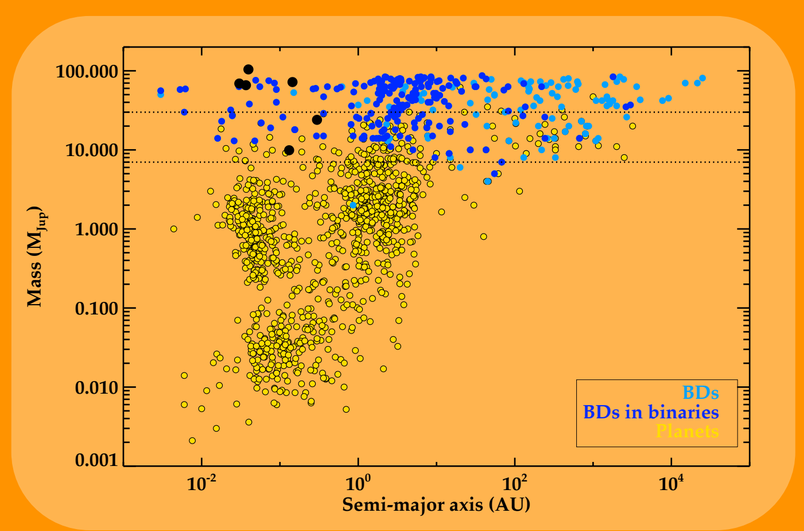


First results (part I)

We have detected clear LC modulations in six KOIs with transiting signals. These variations are mainly caused by tidal interactions between both components due to their closeness (see Figure). The Doppler beaming effect (photometric imprint of the RV motion) is also detected in some of the targets.

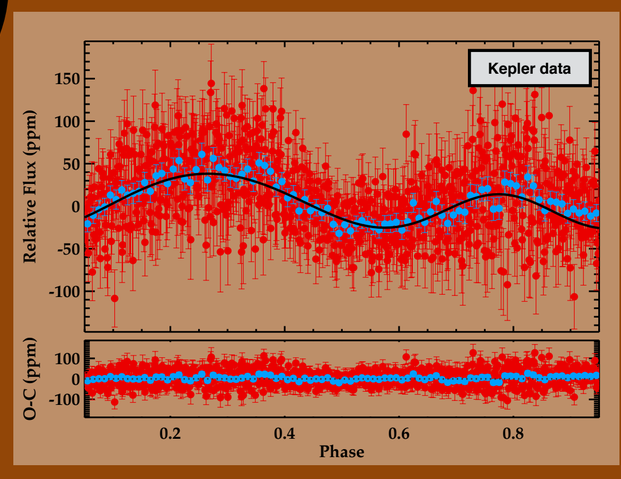
The host stars in three cases could be giant or sub-giant stars.

In these cases, gravitational instabilities due to the evolution of the primary off the main-sequence could have lead an inward migration.



First results (part II)

Another example of a detected companion. In this case, the derived mass lies in the transition region between BDs and planets.

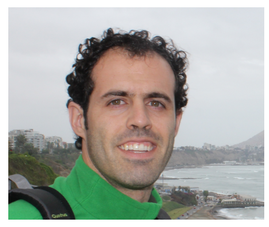


Conclusions

The first results of this study show the need of analyzing the out-of-transit time interval of the LCs of the close-in candidates to confirm or discard their planetary nature. We have found six substellar companions in close-in orbits around six KOIs.

Two of them present masses in the planet-BD limit and show large radii as compared to that predicted by the models (see red piece), suggesting an inflated atmosphere,

All six companions lie in orbits closer than 1 AU, with three of them being closer than 0.1 AU. These close substellar companions suggest important migration processes.



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ESO mail address coming soon…

Why a jigsaw puzzle?

As the 2015 IAP Colloquium is taking place in Paris, I am preparing my PhD defense for the 2nd of July. In order to not bother my colleague Johannes Sahlmann carrying my poster along his numerous trips in June, I had to split the poster into several pieces. And this is the result.